PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-323775

(43)Date of publication of application : 08.11.2002

(51)Int.Cl. G03F 7/40
G03F 7/095
G11B 5/39
H01L 21/027

(21)Application number : 2001-128725

(22)Date of filing : 26.04.2001

(71)Applicant : FUJITSU LTD

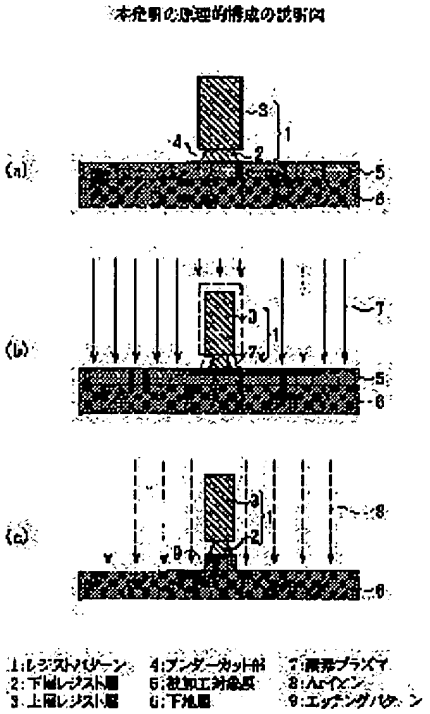
(72)Inventor : SUDA SHOICHI
WATABE KEIJI

(54) PATTERN FORMING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide form resist patterns finer than optical resolution dimensions by using the resist material thus far and exposure means relating to a pattern forming method.

SOLUTION: Two layered resist layers consisting of a lower resist layer 2 which is relatively higher in an etching rate with respect to a developer and an upper resist layer 3 which is relatively smaller in an etching rate are exposed to form the resist patterns 1 of an undercut shape and thereafter the resist patterns 1 are subjected to slimming of their widths.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the pattern formation approach which has the description in the resist pattern structure for making into more detailed width of face than an optical resolution dimension the width of recording track of the giant magneto-resistance film (GMR film) used for the reproducing head (read head) of magnetic recording media, such as a hard disk drive (HDD), about the pattern formation approach, and the formation approach of a resist pattern.
[0002]
[Description of the Prior Art] Conventionally, in connection with the rise of the request of the densification and improvement in the speed to the hard disk drive unit which is the external storage of a computer, the magnetometric sensor which senses the magnetic field itself as the magnetic head for playback has become in use, and although the thing using the magnetic-reluctance (MR) effectiveness was conventionally adopted as such a magnetometric sensor, in current, the thing using the huge magnetic-reluctance (GMR) effectiveness is adopted.
[0003] The playback principle in this MR head or GMR head uses the phenomenon in which the electric resistance of the magnetic thin film which constitutes a magneto-resistive effect component changes with the fields from a record medium, when a fixed sense current is passed from a lead electrode.
[0004] The recording density of the hard disk drive by which the magnetic field to generate is small and current marketing is carried out while a record area of 1 bit decreases with the formation of high density record of a hard disk drive in recent years is 10 Gbit/in2. Although it is order (**1.55 Gbit/cm2), the rise of recording density is large at twice [about] as many annual rate [as this] speed. Therefore, while corresponding to the still minuter magnetic field range, it can be necessary to sense change of a small external magnetic field.
[0005] As mentioned above, since the magnetometric sensor using a spin bulb component is widely used as a magnetometric sensor using giant magneto-resistance now, the magnetometric sensor for playback using such a spin bulb component is explained with reference to drawing 7 . In addition, drawing 7 (a) is the rough sectional view of the conventional magnetometric sensor for playback, and drawing 7 (b) is a rough enlarged drawing in the circle shown with the broken line in drawing 7 (a).
[0006] the lower magnetic-shielding layer 43 and aluminum 2O3 which consist of a NiFe alloy etc. through the substrate layers 42, such as aluminum2 O3 film, on drawing 7 (a) and the (b) aluminum2 O3-TiC substrate 41 which serves as a parent of a slider first 3 ** etc. -- the lower lead gap layer 44 is formed and the spin bulb film 45 is made to deposit on this lower lead gap layer 44 In addition, the spin bulb film 45 in this case consists of the NiFe free layer 47 prepared through Ta substrate layer 46, the CoFe free layer 48, the Cu interlayer 49, a CoFe pinned layer 50, and a PdPtMn antiferromagnetism layer 51, and Ta cap layer 52 is formed on it.
[0007] Subsequently, by forming the resist pattern (illustration being omitted) of a predetermined configuration, and giving ion milling by using this resist pattern as a mask by exposing and developing negatives, according to the usual two-layer resist process, after applying a resist, as shown in drawing, patterning of the spin bulb film is carried out to predetermined width of face. In addition, in this two-layer resist process, while constituting the upper layer from a photoresist which has photosensitivity, in order to form the undercut section as a lower layer, not using a resist layer with the bigger etching rate to the upper developer, photosensitivity is not required from a lower layer resist layer.
[0008] Subsequently, after making hard magnetism film, such as CoCrPt, deposit on the both ends of the spin bulb film by the sputtering method, the hard bias film 53 is formed by removing the unnecessary section of the hard magnetism film by the lift-off method for removing the resist pattern used for patterning of the spin bulb film.
[0009] after [subsequently,] making the electric conduction film which consists of Cr/Au etc. deposit and forming the

lead electrode 54 of a pair -- again -- aluminum 2O3 etc. -- by forming the up magnetic-shielding layer 56 which consists of a NiFe alloy etc. through the up lead gap layer 55, the basic configuration of the magnetometric sensor for playback using a spin bulb component is completed.
[0010] In such a spin bulb giant magneto-resistance component According to the CoFe pinned layer 50 where the magnetization direction was fixed by the PdPtMn antiferromagnetism layer 51, and an external magnetic field, according to the angle with the magnetization direction of the CoFe free layer 48 which the magnetization direction rotates freely, and the NiFe free-lancer Cu47 to make Since dispersion depending on the spin of conduction electron changes and an electric resistance value changes, the signal magnetic field from the situation, i.e., the magnetic-recording medium, of an external magnetic field is acquired by passing the sense current of constant current and detecting this electric resistance value change as an electrical-potential-difference value change.
[0011] In such a spin bulb magnetic-reluctance sensor, to the request of the further detailed-izing, short-wavelength-izing of exposure wavelength, a raise in NA of a lens, and a resist property are supported by improvement etc., for example, the exposure light of the ultraviolet-rays field of short wavelength is used from those, such as 172 etc.nm, in the two-layer resist process using ArF excimer laser etc.
[0012]
[Problem(s) to be Solved by the Invention] However, the development of the resist suitable for the short wavelength exposure light source and the short wavelength after ArF excimer laser light of technique of such detailed-izing of a resist pattern will increase difficulty, and the same detailed-ization as the former will not progress.
[0013] Therefore, this invention aims at forming a more detailed resist pattern than an optical resolving dimension using an old resist ingredient and an old exposure means.
[0014]
[Means for Solving the Problem] Drawing 1 is the explanatory view of the theoretic configuration of this invention, and explains The means for solving a technical problem in this invention with reference to this drawing 1 . in addition, drawing -- setting -- a sign 6 -- aluminum 2O3 etc. -- it is a substrate layer.
In order to attain drawing 1 (a) thru/or the (c) referring-to-above-mentioned purpose, an etch rate is characterized by performing slimming of the width of face of a resist pattern 1, after this invention exposes relatively the two-layer resist layer which turns into the big lower layer resist layer 2 from the small upper resist layer 3 relatively to a developer in the pattern formation approach and an etch rate forms the resist pattern 1 of an undercut configuration.
[0015] Or in case an etch rate performs slimming of the width of face of said resist pattern 1 after an etch rate develops negatives relatively after exposing the two-layer resist layer which turns into the small lower layer resist layer 2 from the big upper resist layer 3 relatively to a developer, and it forms a resist pattern 1, many lower layer resist layers 2 are removed relatively, and it is good also as a resist pattern 1 of an undercut configuration.
[0016] Or slimming of the width of face of said resist pattern 1 may be performed, maintaining said undercut configuration, after forming the resist pattern 1 of the monolayer of an undercut configuration.
[0017] Thus, after patterning of a resist pattern 1, without using a special resist or the exposure approach by performing slimming of the width of face of a resist pattern 1, width of face of a resist pattern 1 can be made more detailed than an optical resolving dimension, by it, the film 5 for [processed] can be processed by the ion milling using Ar ion 8 grade more than an optical resolving dimension, and the detailed etching pattern 9 can be obtained.
[0018] In addition, when using a resist layer as a two-layer structure resist layer, it is desirable to use an organic polymer as a lower layer resist layer 2, using either a phenol resin system resist or Si content resist as an upper resist layer 3.
[0019] As combination of the upper resist layer 3 and the lower layer resist layer 2, in the case of phenol resin system resists, such as a novolak resist, either of acid-resisting mold color content polyimide system resin, such as polyimide system resin, such as big PMGI (LOL-1000) of an etching rate [as opposed to / layer / 3 / upper resist / a developer in especially the lower layer resist layer 2], or ARC, is desirable, and the undercut section 4 can be formed in a development process.
[0020] Moreover, in the case of big Si content resist of resistance [as opposed to the oxygen plasma 7 in the upper resist layer 3], the acid-resisting mold color content polyimide system resin with the large and resistance over developers, such as BARC, and the small resistance over the oxygen plasma 7 of the lower layer resist layer 2, for example, BARC, is desirable, and the undercut section 4 can be formed in a slimming process.
[0021] Moreover, as a slimming process, either oxygen system plasma treatment, the ozonization using UV irradiation or the ozonization using ozone water is desirable. In addition, when performing UV irradiation, it is more desirable than those, such as ArF excimer laser light with a wavelength of 172nm, to use the ultraviolet rays by the side of short wavelength.

[0022]It becomes possible to manufacture the magnetic head for playback which uses the above-mentioned pattern formation approach as a pattern for lift off at the time of forming the time of carrying out patterning of the magneto-resistive effect film, such as spin bulb film, and the magnetic-domain control film (hard bias film), and has the more detailed width of recording track by things.
[0023]
[Embodiment of the Invention] Here, with reference to drawing 2 thru/or drawing 4 , the production process of the magnetometric sensor for playback of the gestalt of operation of the 1st of this invention is explained.
Drawing 2 (a) on the aluminum2 O3-TiC substrate used as the parent of a slider as usual first 3 ** aluminum 2O3 aluminum 2O3 after preparing the lower magnetic-shielding layer (all omit illustration) which consists of a NiFe alloy through the film The lower lead gap layer 11 which consists of film is formed. Subsequently The spin bulb film 12 is formed on the lower lead gap layer 11 using the sputtering method.
[0024] Drawing 2 (b) reference drawing 2 (b) is an enlarged drawing in the circle shown with the broken line in drawing 2 (a). The spin bulb film 12 in this case 5nm Ta substrate layer 13 and thickness for example, the 2nm NiFe free layer 14 and thickness [thickness] The 2nm CoFe free layer 15 and thickness for example, for example, the 2.4nm Cu interlayer 16 and thickness For example, it is constituted, when the 2nm CoFe pinned layer 17 and thickness carry out the 13nm PdPtMn antiferromagnetism layer 18 and thickness carries out sequential membrane formation of the 6nm Ta cap layer 19. In addition, the presentation ratio of the NiFe free layer 14 in this case is nickel81Fe19, and the presentation of the CoFe free layer 15 and the CoFe pinned layer 17 is Co90Fe10, and the presentation ratio of the PdPtMn antiferromagnetism layer 18 is Pd31Pt17Mn52 further.
[0025] Drawing 2 (c) 3 **, subsequently to the spin bulb film 12 top, thickness applies the 0.1-micrometer PMGI layer 20, thickness applies the 0.5-micrometer novolak resist layer 21, and a two-layer resist is constituted. In addition, since the PMGI layer 20 used as the lower layer resist layer in this case does not have photosensitivity, it is not a photoresist.
[0026] Drawing 3 (d) After exposing by irradiating ultraviolet rays with a wavelength of 172nm subsequently using ArF excimer laser 3 **, width of face forms the 0.28-micrometer resist pattern 22 and the PMGI layer pattern 23 by developing negatives using the developer which consists of 2.38% of tetramethylammonium hydroxide water. In this case, since the etching rate [as opposed to a developer in the PMGI layer 20] is large, the undercut section is formed in an interface with a resist pattern 22 as usual.
[0027] Drawing 3 (e) 3 **, subsequently, an parallel monotonous mold plasma etching system is used, and it is O2. The oxygen plasma 24 which impressed the high-frequency power of 25W (/176cm2), and was generated where gas is made into the pressure of 8sccm sink 200Torr performs slimming of a resist pattern 22 and the PMGI layer pattern 23.
[0028]
[Table 1]

表1

プラズマ処理時間	0分	1分	2分	3分
レジスト幅（μm）	0．278	0．251	0．217	0．181

If slimming during 1 minute is performed on condition that the above as shown in Table 1, 0.278-micrometer resist width of face will become as slim about 10% as 0.251 micrometers, and it is set to 0.181 micrometers by slimming for 0.217 micrometers and 3 minutes by slimming for 2 minutes, and the undercut configuration was also maintained mostly.
[0029] Drawing 3 (f) 3 **, subsequently, by slimming, it etches until the lower lead gap layer 11 exposes the spin bulb film 12 by giving ion milling using the Ar ion 25 by using as a mask the resist pattern 22 set to 0.22 micrometers, and width of face forms the spin bulb component pattern 26 which has predetermined width of face.
[0030] Thickness deposits the 80nm CoCrPt film 27 by the sputtering method, using the drawing 4 (g) reference length then a resist pattern 22, and the PMGI layer pattern 23 as a pattern for lift off as it is.
[0031] Drawing 4 (h) Subsequently to a resist pattern 22 top, the hard bias film 28 joined to the both-sides side of the spin bulb component pattern 26 is formed 3 ** by removing the CoCrPt film 27 deposited with the resist pattern 22 and the PMGI layer pattern 23.
[0032] Drawing 4 (i) Subsequently vacuum deposition is used 3 **. 3nm Cr adhesion layer and thickness for example, [thickness] The lead electrode 29 which consists of Cr/Au film of a pair by giving ion milling which used a new resist pattern as the mask again after making 30nm Au electrode layer deposit is formed. Subsequently aluminum 2O3 etc. -- the basic configuration of the magnetometric sensor for playback is completed by preparing the up magnetic-shielding layer (all omitting illustration) which consists of a NiFe alloy etc. through an up lead gap layer.

[0033] The gestalt of operation of the 1st of this this invention can make the width method of a resist pattern the detailed dimension beyond an optical resolving dimension, using a conventional resist ingredient and the conventional exposure approach, since the slimming process using the oxygen plasma was performed, after forming a resist pattern by exposure and development, and detailed-ization of the magnetometric sensor for playback is attained by it.
[0034] Moreover, in the gestalt of this 1st operation, since PMGI is used as a lower layer resist layer, while being able to form the undercut section at a development process, also in a slimming process, an undercut configuration can be maintained mostly, and it can perform lift off certainly.
[0035] Next, although the production process of the magnetometric sensor for playback of the gestalt of operation of the 2nd of this invention is explained with reference to drawing 5 , since it is completely the same as that of the gestalt of the 1st operation of the above except a two-layer resist process, explanation is simplified.
Drawing 5 (a) on the aluminum2O3-TiC substrate used as the parent of a slider completely like the gestalt of the 1st operation of the above first 3 ** aluminum 2O3 aluminum 2O3 after preparing the lower magnetic-shielding layer (all omit illustration) which consists of a NiFe alloy etc. through the film etc. -- the lower lead gap layer 11 is formed and, subsequently the spin bulb film 12 is deposited using the sputtering method.
[0036] Subsequently, after thickness's applying the 0.1-micrometer BARC layer 31, and thickness's applying 0.5-micrometer Si content resist layer and forming a two-layer resist layer on the spin bulb film, the same exposure and development as the gestalt of the 1st operation of the above are performed. In this case, since the resistance over the developer with which the BARC layer 31 consists of tetramethylammonium hydroxide water is large, it is hardly etched, only Si content resist is developed, and 0.28-micrometer Si content resist pattern 32 is formed for width of face. In addition, the developer resistance in ARC which turns into BARC from the polyimide system resin containing the color for acid resisting is raised.
[0037] Drawing 5 (b) The width of face of Si content resist pattern 32 is slimmed to 0.22 micrometers by subsequently performing slimming processing using the oxygen plasma 24 on the same conditions as the gestalt of the 1st operation of the above 3 **.
[0038] In this case, to a thing with the large oxygen plasma resistance of Si content resist pattern 32, since the oxygen plasma resistance of the BARC layer 31 is small, while Si content resist pattern 32 slims, the BARC layer pattern 33 which the outcrop of the BARC layer 31 is etched and has an undercut configuration is formed.
[0039] By giving ion milling using the Ar ion 25 by using Si content resist pattern 32 as a mask like the gestalt of the 1st operation of the above, the outcrop of the spin bulb film 12 is removed after the drawing 5 (c) reference, and it forms the spin bulb film pattern 26.
[0040] Although illustration is omitted, after forming the hard bias film henceforth using the lift-off method, the basic structure of the magnetometric sensor for playback of the gestalt of operation of the 2nd of this invention is completed by carrying out sequential formation of the lead electrode of a pair, an up lead gap layer, and the up magnetic-shielding layer.
[0041] Also in the gestalt of this 2nd operation, the width method of a resist pattern can be made into the detailed dimension beyond an optical resolving dimension like the gestalt of the 1st operation only by the formation processes of the undercut section differing, with a conventional resist ingredient and the conventional exposure approach used, and detailed-ization of the magnetometric sensor for playback is attained by it.
[0042] Next, although the production process of the magnetometric sensor for playback of the gestalt of operation of the 3rd of this invention is explained with reference to drawing 6 , since it is completely the same as that of the gestalt of the 1st operation of the above except a resist process, explanation is simplified.
Drawing 6 (a) on the aluminum2O3-TiC substrate used as the parent of a slider completely like the gestalt of the 1st operation of the above first 3 ** aluminum 2O3 aluminum 2O3 after preparing the lower magnetic-shielding layer (all omit illustration) which consists of a NiFe alloy etc. through the film etc. -- the lower lead gap layer 11 is formed and, subsequently the spin bulb film 12 is deposited using the sputtering method.
[0043] Subsequently, the top width of face which performed the exposure and the development as the gestalt of the 1st operation of the above with it forms the 0.28-micrometer resist pattern 35 on the spin bulb film. [same after thickness applies the 0.5-micrometer resist SIPR9706 (trade name made from the Shin-etsu chemistry)] In this case, since a resist SIPR9706 (trade name made from the Shin-etsu chemistry) has the property which becomes back taper-like by development, the back taper-like resist pattern 35 is obtained.
[0044] Drawing 6 (b) The width of face of a resist pattern 35 is slimmed to 0.22 micrometers by subsequently performing slimming processing using the oxygen plasma 24 on the same conditions as the gestalt of the 1st operation of the above 3 **, with a back taper configuration maintained.
[0045] By giving ion milling using the Ar ion 25 by using a resist pattern 35 as a mask like the gestalt of the 1st

operation of the above, the outcrop of the spin bulb film 12 is removed after the drawing 6 (c) reference, and it forms the spin bulb film pattern 26.

[0046] Although illustration is omitted, after forming the hard bias film henceforth using the lift-off method, the basic structure of the magnetometric sensor for playback of the gestalt of operation of the 3rd of this invention is completed by carrying out sequential formation of the lead electrode of a pair, an up lead gap layer, and the up magnetic-shielding layer.

[0047] In the gestalt of this 3rd operation, since the undercut section be further form by the resist of structure, while a resist process be simplify, like the gestalt of the 1st operation, the width method of a resist pattern can be make into the detailed dimension beyond an optical resolving dimension, with a conventional resist ingredient and the conventional exposure approach use, and detailed-ization of the magnetometric sensor for playback be attain by it.

[0048] As mentioned above, although the gestalt of each operation of this invention has been explained, this invention is not restricted to the configuration indicated in the gestalt of each operation, and various kinds of modification is possible for it. For example, in explanation of the gestalt of each above-mentioned operation, although slimming processing is performed using the oxygen plasma, it may not be restricted to oxygen plasma treatment, and ozonization is sufficient.

[0049] For example, you may slim by exposing a resist pattern to the ozone which used for example, Xe excimer light, irradiated 172nm ultraviolet rays, made the oxygen gas introduced in the reaction chamber generate ozone, and it was made to generate.

[0050] Or the generated ozone may be dissolved in ultrapure water, ozone water may be produced, and you may slim by wet processing immersed in this ozone underwater in a resist pattern.

[0051] Moreover, in the gestalt of the 1st operation of the above, as a lower layer resist layer, although PMGI is used, it is not restricted to PMGI and ARC which consists of polyimide system resin which other organic polymers are sufficient as, for example, contained the color for acid resisting may be used.

[0052] Moreover, in the gestalt of the 1st operation of the above, although the novolak resist which is a phenol resin system resist is used as an upper resist layer, not to be restricted to a novolak resist, to use other phenol resin system resists, and what is necessary is just a positive resist with high sensibility to ultraviolet rays anyway.

[0053] Moreover, in the gestalt of each above-mentioned operation, although the magneto-resistive effect component is used as the single spin bulb component of the mold which has an antiferromagnetism layer in the bottom, the single spin bulb component or dual spin bulb component of the mold which has an antiferromagnetism layer in the bottom may be used, and the further usual MR component may be used.

[0054] Moreover, in the gestalt of each above-mentioned operation, although the lead electrode is considering as the magnetometric sensor of the exaggerated RAID structure of contacting Ta cap layer, the electric conduction film for lead electrodes is made to deposit on deposition of the hard magnetism film for hard bias film succeedingly, and the hard bias film and a lead electrode may be formed in it in self align by lift off.

[0055] Moreover, it is needless to say that it may not pass over the quality of the material of the magnetic layer indicated in the gestalt of each above-mentioned operation, an antiferromagnetism layer, and a conductive layer to a mere example, but you may use combining various kinds of well-known magnetic materials, an antiferromagnetism ingredient, and an electrical conducting material.

[0056] Moreover, in explanation of the gestalt of each operation of this invention, although explained as an independent magnetometric sensor for the reproducing heads, this invention is that it cannot be overemphasized that it is what is applied also as a magnetometric sensor for the reproducing heads which constitutes the compound-die thin film magnetic head which it is not restricted to an independent magnetometric sensor and carried out the laminating to the thin film magnetic head of an induction type, either.

[0057] Furthermore, although this invention is explained as the pattern formation approach used for the production process of the magnetometric sensor for playback, it is not restricted to the production process of the magnetometric sensor for playback, and while performing a photolithography process using ultraviolet rays, it is applied to the formation process of the detailed pattern which performs lift off, and it becomes possible to form a detailed pattern by the high throughput simply by the electron-beam-exposure approach.

[0058] Here, with reference to drawing 1 , the detailed description of this invention is explained again.

Refer to drawing 1 (a) thru/or (c) (additional remark 1). The pattern formation approach characterized by performing slimming of the width of face of said resist pattern 1 while the etch rate had maintained said undercut configuration, after the etch rate developed negatives relatively after exposing the two-layer resist layer which turns into the big lower layer resist layer 2 from the small upper resist layer 3 relatively to a developer, and it formed the resist pattern 1 of an undercut configuration.

(Additional remark 2) The pattern formation approach characterized by removing many lower layer resist layers 2 relatively, and considering as the resist pattern 1 of an undercut configuration in case an etch rate performs slimming of the width of face of said resist pattern 1 after an etch rate develops negatives relatively after exposing the two-layer resist layer which turns into the small lower layer resist layer 2 from the big upper resist layer 3 relatively to a developer, and it forms a resist pattern 1.
(Additional remark 3) The pattern formation approach indicated by the additional remarks 1 or 2 characterized by using an organic polymer as the above-mentioned lower layer resist layer 2, using either a phenol resin system resist or Si content resist as the above-mentioned upper resist layer 3.
(Additional remark 4) the above-mentioned upper resist layer 3 -- from a phenol resin system resist -- becoming -- the above-mentioned lower layer resist layer 2 -- either polyimide system resin or acid-resisting mold color content polyimide system resin -- the pattern formation approach of the additional remark 3 publication characterized by things.

(Additional remark 5) The pattern formation approach of the additional remark 3 publication characterized by for the above-mentioned upper resist layer 3 consisting of an Si content resist, and the above-mentioned lower layer resist layer 2 consisting of acid-resisting mold color content polyimide system resin with big resistance to the above-mentioned developer.
(Additional remark 6) The pattern formation approach characterized by performing slimming of the width of face of said resist pattern 1, maintaining said undercut configuration after forming the resist pattern 1 of the monolayer of an undercut configuration.
(Additional remark 7) The additional remark 1 characterized by the above-mentioned slimming process being either oxygen plasma treatment, the ozonization using UV irradiation or ozonization using ozone water thru/or the pattern formation approach given in any 1 of 6.
(Additional remark 8) The additional remark 1 characterized by being a pattern for lift off at the time of forming the magnetic-domain control film while the above-mentioned resist pattern 1 is a pattern which carries out patterning of the magneto-resistive effect film thru/or the pattern formation approach given in any 1 of 7.
[0059]
[Effect of the Invention] Since according to this invention slimming is performed after forming a resist pattern, the place which contributes to spread and low-pricing of the HDD equipment of high recording density by it by becoming possible to form a more detailed resist pattern than an optical resolving dimension using an old resist ingredient and an old exposure means is large.

[Translation done.]